U.S. Fish & Wildlife Service

Abundance and Run Timing of Adult Salmon in the Gisasa River, Koyukuk National Wildlife Refuge, Alaska, 2006

Alaska Fisheries Data Series Number 2007–1

Fairbanks Fish and Wildlife Field Office
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Jeff Adams and Thomas McLain

Abstract

A resistance board weir was operated on the Gisasa River between June 28 and July 29, 2006 to collect information on abundance, run timing, and biology of returning salmon. This was the thirteenth year of operating a weir at this location. A total estimate of 3,030 Chinook *Oncorhynchus tshawytscha* and 261,305 chum salmon *O. keta* passed through the weir. Also counted were 44 pink salmon *O. gorbuscha* and 25 sockeye salmon *O. nerka*. The most abundant non-salmon species was Arctic grayling *Thymallus arcticus* (N=19), followed by northern pike *Esox lucius* (N=17), longnose sucker *Catostomus catostomus* (N=8), and whitefish (Coregoninae; N=7). The estimate for the weekly sex ratio for Chinook salmon ranged from 26% to 35% female fish. Three primary age classes, 1.2, 1.3, and 1.4, were identified from 530 Chinook salmon aged. Age class 1.3 dominated with weekly estimates ranging from 56% to 86%. Female Chinook salmon ranged from 435 to 980 mm mid-eye-to fork length (MEL) and males ranged from 440 to 900 mm MEL. Mean length-at-age measurements of female fish older than 5 years were larger than males. Chum salmon weekly sex ratios ranged from 43% to 63% female fish. There were two primary age classes, 0.3 and 0.4, identified from 496 chum salmon aged. The run was dominated by age class 0.4 which comprised 76-93 % of the weekly estimates.

Introduction

The Gisasa River provides spawning and rearing habitat for Chinook *Oncorhynchus tshawytscha* and chum *O. keta* salmon. The Gisasa River is located within the Koyukuk National Wildlife Refuge (Refuge) and is a major tributary flowing into the Koyukuk River drainage. The Refuge is located near the villages of Galena and Koyukuk in north-central Interior Alaska. Chinook and summer chum salmon from the Gisasa River contribute to the mixed stock subsistence and commercial fisheries occurring in the Yukon River drainage (USFWS 1993).

Within federal conservation units, continued subsistence use of fish and wildlife resources by rural residents and the conservation of those resources are mandated in the Alaska National Interests Lands Conservation Act (1980). Yukon River salmon stocks, especially chum salmon, began to decline in the late 1990s (Kruse 1998) and this led to harvest restrictions, complete fishery closures, and spawning escapements below management goals (Vania et al. 2002). Management of individual stocks does not occur and accurate escapement data are limited throughout the Yukon River drainage. The inseason management of the salmon fisheries is conducted on information provided from the preseason projections based on parent stock returns, test fisheries, Pilot Station sonar, run strength from escapement projects, and subsistence and commercial harvest data.

Author: Jeff Adams is the branch chief of the Fisheries and Habitat Restoration Branch, Fairbanks Fish and Wildlife Field Office (FFWFO) which operated the weir in 2006. Since that time it has been transferred to the Subsistence Branch, FFWFO where Thomas McLain, fish biologist, is the office contact on the project. Jeff Adams and Thomas McLain can be contacted at Fairbanks Fish and Wildlife Field Office, U.S. Fish and Wildlife Service, 101 12th Avenue, Room 110, Fairbanks, Alaska 99701 or jeff_adams@fws.gov, or thomas_mclain@fws.gov.

Historically, escapement information on individual salmon stocks from the Koyukuk River has been collected by aerial surveys. The Alaska Department of Fish and Game conducted these surveys on several index tributaries within the Koyukuk River drainage intermittently since 1960 (Barton 1984). Aerial surveys are highly variable and are only an index of relative run strength. Salmon escapement projects using fish weirs and counting towers can provide good escapement estimates for evaluating management practices. Since 1994, the U.S. Fish and Wildlife Service-Fairbanks Fish and Wildlife Field Office (FFWFO), Bureau of Land Management (BLM), and the Tanana Chiefs Conference, Inc. (TCC) have operated escapement projects in five different Koyukuk River tributaries using floating weirs and counting towers. Weirs have been used on the Gisasa River by FFWFO since 1994 (O'Brien 2006), on Henshaw Creek since 2000 (Berkbigler and Elkin 2006), the South Fork of the Koyukuk River from 1996 to 1997 (Wiswar 1997, 1998a), and on the Kateel River in 2002 (VanHatten 2005). Counting towers were operated by BLM and TCC on Clear Creek, a tributary of the Hogatza River, from 1995 to 2000 (VanHatten 1999), and Henshaw Creek in 1999 (VanHatten 1999). From 2001 to 2005 on Clear Creek, BLM used a picket weir, and in 2006 a partial weir was employed in conjunction with a video camera to monitor escapement (D. Esse, Bureau of Land Management, Fairbanks, personal communication).

In the Gisasa River, Chinook salmon escapement, based on weir counts from 1994 to 2005, ranged from 1,774 to 4,023 fish (Figure 2; Appendix). Chum salmon escapement for the same period ranged from 10,155 to 172,259 fish (Figure 3; Appendix). This report describes the 2006 Gisasa River escapement project conducted by FFWFO. The objectives of the 2006 study were to: 1) determine daily escapement and run timing of adult salmon; 2) determine sex and size composition of adult salmon; and 3) determine the presence and movement of resident fish.

Study Area

The Gisasa River is located 90 km upriver from the mouth of the Koyukuk River in the western interior of Alaska (Figure 1). The headwaters originate in the Nulato Hills and the river flows 112 km northeast, passing through the Koyukuk Refuge, before draining into the Koyukuk River (65° 25.254' N, 157° 71.570' W; USGS 1:63,360 series, Kateel River B-4 quadrangle). Climate conditions of the Koyukuk River drainage are characteristically continental with seasonal temperature variations and very low precipitation. The air temperature ranges from 18° C during summer months to -57° C during winter months (USFWS 1993). The hydrology of this area is very dynamic throughout the year with high water levels during spring and low water levels in summer.

The Gisasa River channel configuration meanders with alternating cut banks and gravel bars. The substrate varies from gravel and cobble in high velocity areas to mud and silt in lower velocity areas. The lower river sections are characteristically more uniform in appearance with gradual sloping mud banks and emergent shoreline vegetation (USFWS 1993). The weir site is located approximately 4 km upriver from the mouth of the Gisasa River. This site was selected for its uniform bottom contour, width (45 m), depth (0.5 m), and substrate composition (medium size gravel 25-50 mm intermediate diameter).

Methods

Weir Construction

A resistance board weir was used to collect escapement counts and biological information from adult salmon as they migrated into Henshaw Creek to spawn. The start date of the project was based on previous years' salmon run timing data. The end date of the project was determined inseason when the daily count of each species dropped to less than 1% of the seasonal passage to date and continued at this low level for three or more consecutive days. The construction and installation of resistance board weirs was described by Tobin (1994). Each picket of the weir is schedule-40, polyvinyl chloride electrical conduit with a 2.5 cm inside diameter. The space between individual pickets is 3.2 cm. During daily visual inspection, the weir was cleaned of debris, fish carcasses, and gravel dislodged by spawning fish. A live trap installed near mid-channel allowed salmon and resident fish species to be recorded as they passed through the weir.

Biological Data

Run timing and abundance of adult Chinook and chum salmon were estimated by recording the number of each species of fish passing through the weir each day. Because non-salmon species were not handled, it was difficult to identify different whitefish species; therefore all whitefish species were grouped under the subfamily Coregoninae.

The daily counting schedule was dependent upon the level of fish passage through the weir. During the beginning and end of the run, when hourly counts were low, counting was conducted between 0800 and 2400 hours, with the trap closed from 2400 to 0800 hours to prevent upstream passage during unmonitored times. As the run increased in strength, the counting schedule increased to 24 hours a day, 7 days a week.

A stratified random sampling scheme was used to collect age, sex, and length ratio information from both adult salmon species. Sampling started at the beginning of each week and generally was conducted over a 3-4 day period, targeting 160 salmon/species/week. Scales were used for aging salmon with age class information being reported using the European technique (Foerster 1968). Three scales were collected from Chinook salmon and one scale from chum salmon. Scales were sampled from the area located on the left side of the fish and two rows above the lateral line on a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin. Scales from both adult salmon species were sent to the Alaska Department of Fish and Game for processing. Some scales could not be aged due to loss or deterioration. These were placed in a category called unknown age and data from these fish were not included in sample sizes or any age, sex or length calculations. Lengths of Chinook and chum salmon were measured to the nearest 5 mm from mid-eye to fork of the caudal fin (MEL). Sex ratio data were collected during age and length sampling. Sex of each fish was visually determined by secondary sex characteristics. Daily escapement counts and sex ratios were reported daily by way of satellite telephone to the FFWFO in Fairbanks.

Data Analysis

When daily counts were missed due to high water, they were estimated by linear interpolation between the daily counts before and after the high water event. Incomplete 24h counts due to high water were adjusted for a 24h period if the total hours sampled were greater than 6h. In this case, the total hours counted were taken as a percent of 24h and adjusted for a full day. If

counting occurred less than 6h of the day, the data were disregarded and the day was interpolated as if it were a full missing day.

Calculations for age and sex information were treated as a stratified random sample (Cochran 1977) with statistical weeks as the strata. Methods used in past years were initially attempted to estimate sex and age composition of the run; however, this was not accomplished in 2006 because of the low number of fish sampled in the early part of the run. Only the weekly age and sex composition of Chinook and chum salmon are presented. The formulas used in past years are retained in this report and presented below to maintain continuity of prescribed methods.

Each statistical week was defined as beginning on Monday and ending on Sunday. Within a week, the proportion of the samples composed of a given sex or age, $\hat{p}_{ij}$, were calculated as

$$\hat{p}_{ij} = \frac{n_{ij}}{n_j},$$

where n_{ij} is the number of fish by sex *i* or age *i* sampled in week *j*, and n_j is the total number of fish sampled in week *j*. The variance of $\hat{p}_{ij}$ was calculated as

$$\hat{v}(\hat{p}_{ij}) = \frac{\hat{p}_{ij}(1-\hat{p}_{ij})}{n_j - 1}.$$

Sex and age compositions for the total run of Chinook and chum salmon of a given sex/age, $\hat{p}_i$ were calculated as

$$\hat{p}_i = \sum_{j-1} \hat{W}_j \hat{p}_{ij,}$$

where the stratum weight $\hat{W}_j$ was calculated as

$$\hat{W}_j = \frac{N_j}{N},$$

and N_j equals the total number of fish of a given species passing through the weir during week *j*, and *N* is the total number of fish of a given species passing through the weir during the run. Variance, $\hat{v}(\hat{p}_i)$ of sex and age compositions for the run was calculated as

$$\hat{v}(\hat{p}_i) = \sum_{j-1} \hat{W}_j^2 \hat{v}(\hat{p}_{ij}).$$

Results and Discussion

Weir Operation

The Gisasa River weir was operated from June 28 to July 29, 2006 (Table 1). The picket spacing within the trap and weir panels was narrow enough to prevent adult Chinook and chum salmon

from passing through the weir. However, some of the smaller fish species, such as Arctic grayling and whitefish, likely passed through the weir undetected.

Biological Data

A total estimate of 3,030 Chinook and 261,305 chum salmon passed through the weir (Table 1). Also counted were 44 pink salmon *O. gorbuscha* and 25 sockeye salmon *O. nerka*. The most abundant non-salmon species was Arctic grayling *Thymallus arcticus* (N=19), followed by northern pike *Esox lucius* (N=17), longnose sucker *Catostomus catostomus* (N=8), and whitefish (Coregoninae; N=7).

The first Chinook salmon was counted on June 29, and thereafter the species was counted consistently throughout the run (Table 1; Figure 4). The first quartile migrated through the weir by July 10, the median migration date was July 13, and the third quartile passed the weir on July 17. There were 565 Chinook salmon sampled for age composition with 35 of the samples of unknown age (Table 2). There were three primary age classes: 1.4, 1.3, and 1.2 from brood years 2000, 2001, and 2002, respectively. Age class 1.3 dominated with weekly estimates ranging from 56% to 86%. Also included were fish in classes 1.1, 2.3, 1.5, and 2.4 which individually comprised < 1% of the sample in their strata. The estimate for the weekly Chinook salmon sex ratio ranged from 26 to 35% female fish (Table 2). Female Chinook salmon ranged from 435 to 980 mm MEL and males ranged from 440 to 900 mm MEL. For length-at-age measurements, mean lengths of female fish older than 5 years were larger than males (Table 3).

The first chum salmon was counted on June 28, and thereafter the species was counted consistently throughout the run (Table 1; Figure 5). Because of the high number of fish counted the first day, it is probable that chum salmon began to migrate upriver prior to the installation of the weir. The first quartile migrated through the weir by July 4, the median migration date was July 7, and the third quartile passed the weir on July 12. There were 542 chum salmon sampled for sex and age composition with 46 of the fish of unknown age (Table 4). The weekly chum salmon sex ratio for the latter part of the run ranged from 43% to 63% female fish. Age composition of sampled chum salmon consisted primarily of two age classes: age 0.4 and age 0.3. The run was dominated by age class 0.4 which comprised 76-93 % of the weekly estimates. Also included was a small number of age 0.2 fish (< 1%/strata; Table 4). For length-at-age measurements, mean lengths of male fish were larger than females of the same age (Table 5).

In 2006, Chinook salmon run timing and the escapement estimate were within the range estimated during previous years at the weir (Figure 3; Appendix 1). However, chum salmon escapement in 2006 was the highest recorded at the weir and exceeded the previous high count from 2005 by approximately 90,000 fish. The mid-point of the chum salmon run timing was up to 7 days earlier in 2006 than previously recorded (cf. O'Brien 2006).

Acknowledgements

Appreciation is extended to crew leader Bill Carter and crew members Kolby Bissell and Janelle Jensen who recorded biological information during the 2006 field season. The U.S. Fish and Wildlife Service, Office of Subsistence Management, provided funding support through the Fisheries Resource Monitoring Program, under project number FIS 04-209.

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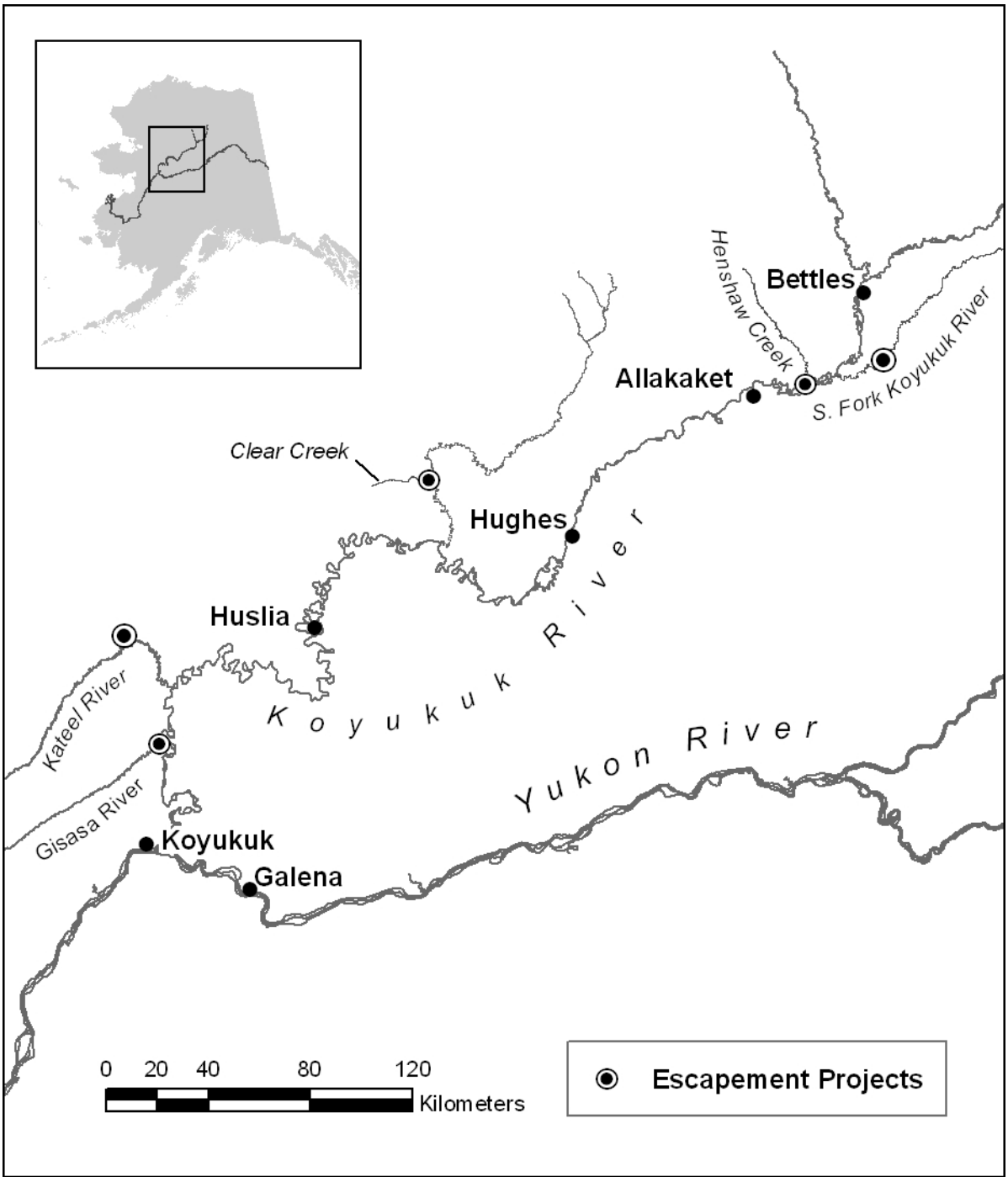

Figure 1. Location of the Gisasa River weir and other active and historical tributary escapement project sites in the Koyukuk River drainage, Alaska.

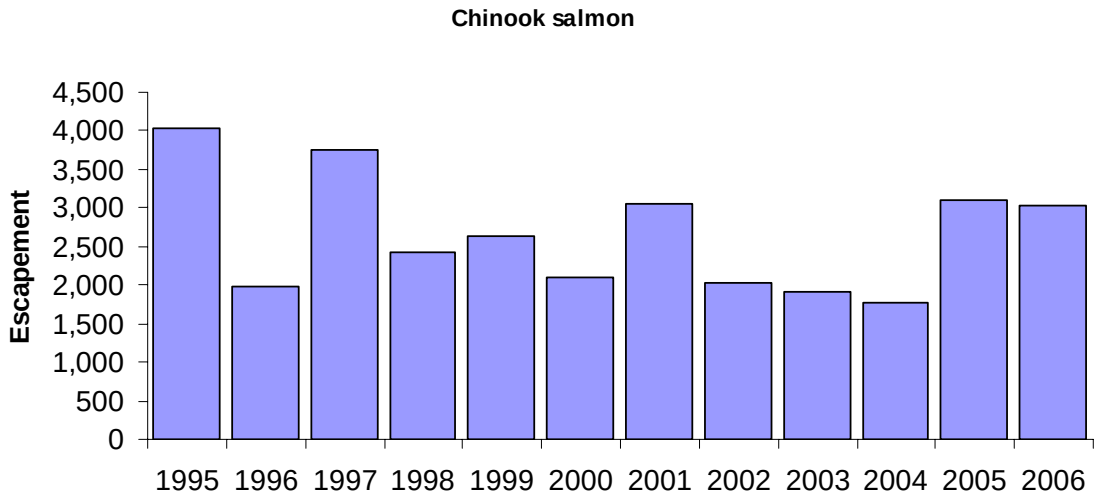

Figure 2. Chinook salmon escapement at the Gisasa River weir 1995-2006. The weir was operational in 1994, the first year, but is not included here as counting did not begin until July 10.

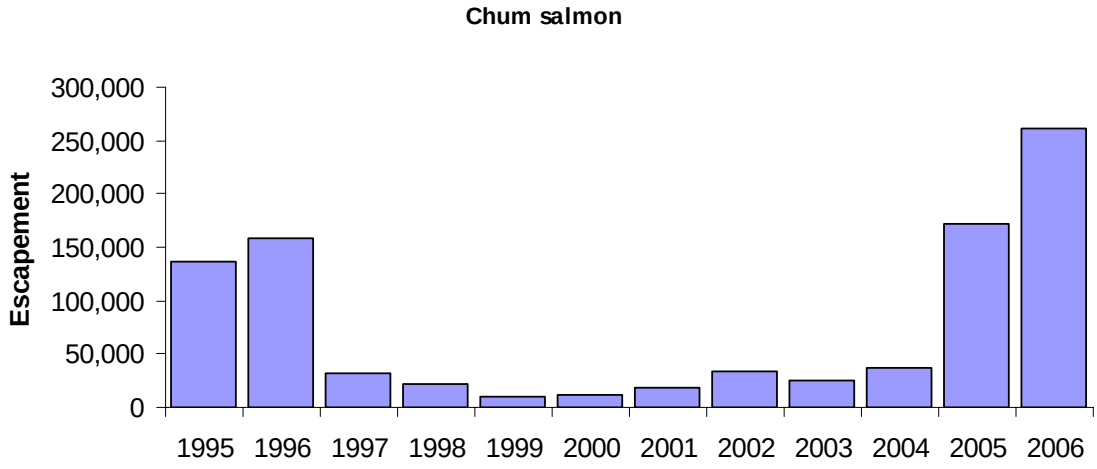

Figure 3. Chum salmon escapement at the Gisasa River weir 1995-2006. The weir was operational in 1994, the first year, but is not included here as counting did not begin until July 10.

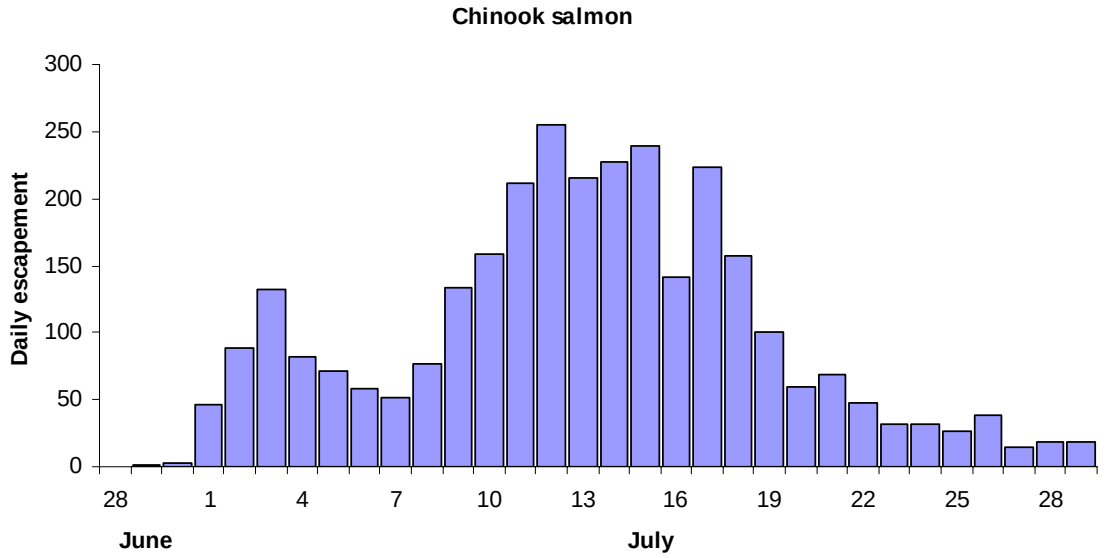

Figure 4. Daily escapement estimates of Chinook salmon at the Gisasa River weir, June 28 - July 29, 2006.

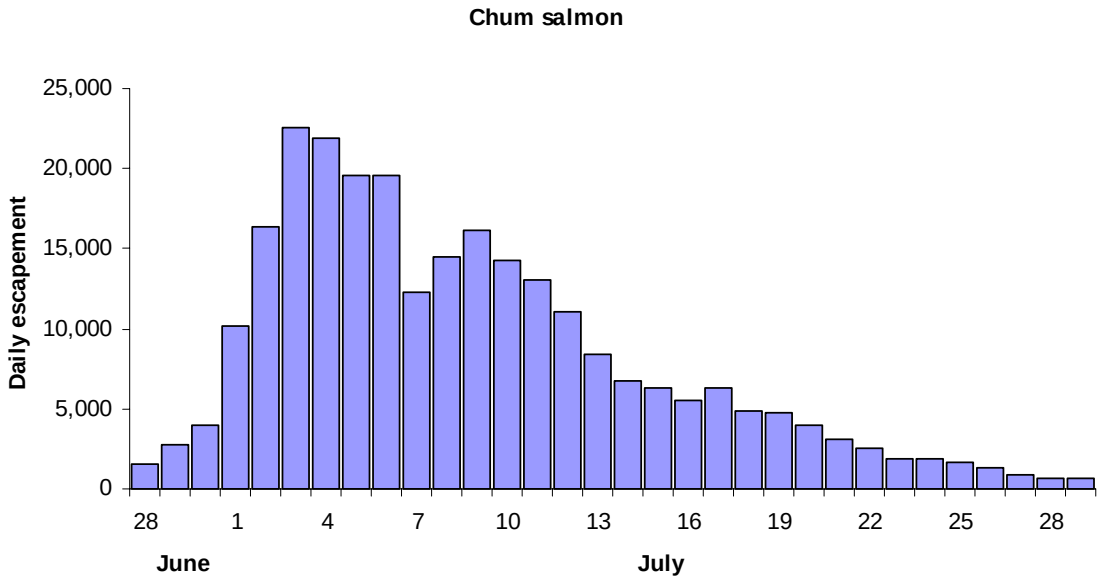

Figure 5. Daily escapement estimates of chum salmon at the Gisasa River weir, June 28 - July 29, 2006.

Table 1. Daily estimates and cumulative estimates of fish passing the Gisasa River weir, Alaska, 2006. Cum = cumulative. * = counts for Chinook and chum salmon only were interpolated or adjusted to 24 hrs on these dates due to high water. ☼ = first, mid, and third quartiles for Chinook and chum salmon escapement run timing.

	Chinook salmon		Chum salmon		Pink salmon	Sockeye salmon	Arctic grayling	Northern pike	Longnose sucker	Whitefish spp.
Date	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily	Daily	Daily
Jun 28	0	0	1,560	1,560	0	0	0	0	0	0
Jun 29	1	1	2,788	4,348	0	0	0	0	0	0
Jun 30 *	3	4	3,996	8,344	0	0	0	0	0	0
Jul 1 *	46	49	10,192	18,536						
Jul 2 *	89	138	16,387	34,923				0		
Jul 3 *	132	270	22,583	57,505	0	0	2	0	0	0
Jul 4	82	352	21,897	☼ 79,402	0	0	1	3	1	1
Jul 5	72	424	19,597	98,999	2	0	3	2	0	0
Jul 6	58	482	19,538	118,537	0	0	3	2	2	0
Jul 7	52	534	12,310	☼ 130,847	1	0	1	0	2	0
Jul 8	77	611	14,500	145,347	0	0	1	5	0	0
Jul 9	134	745	16,121	161,468	0	0	1	1	0	1
Jul 10	159	☼ 904	14,216	175,684	0	0	0	0	0	1
Jul 11	211	1,115	13,101	188,785	1	0	1	0	2	1
Jul 12	255	1,370	11,011	☼ 199,796	1	0	1	1	0	0
Jul 13	216	☼ 1,586	8,398	208,194	2	0	0	0	0	0
Jul 14	227	1,813	6,795	214,989	2	1	0	0	0	1
Jul 15	239	2,052	6,286	221,275	0	0	0	1	0	0
Jul 16	141	2,193	5,477	226,752	1	0	0	0	0	0
Jul 17	224	☼ 2,417	6,257	233,009	1	0	0	0	0	0
Jul 18	157	2,574	4,847	237,856	2	0	0	0	0	1
Jul 19	101	2,675	4,734	242,590	3	0	0	0	0	0
Jul 20	59	2,734	3,991	246,581	5	3	0	1	0	0
Jul 21	69	2,803	3,082	249,663	4	0	1	0	0	0
Jul 22	48	2,851	2,498	252,161	3	0	0	0	0	0
Jul 23	32	2,883	1,922	254,083	7	3	0	0	0	1
Jul 24	32	2,915	1,929	256,012	1	3	0	0	0	0
Jul 25	26	2,941	1,689	257,701	1	3	1	0	0	0
Jul 26	38	2,979	1,360	259,061	2	3	1	0	1	0
Jul 27	14	2,993	847	259,908	4	3	2	0	0	0
Jul 28	19	3,012	681	260,589	1	2	0	1	0	0
Jul 29	18	3,030	716	261,305	0	4	0	0	0	0
Total	3,030		261,305		44	25	19	17	8	7

Table 2. Age and sex ratio estimates of Chinook salmon sampled at the Gisasa River weir, Alaska, 2006.

					Brood year and age						
					2003	2002	2001	2000		1999	
Strata	Run size (N)	Sample size (n)	Sex ratio % female	Number fish of unknown age	1.1	1.2	1.3	1.4	2.3	1.5	2.4
Jun 28 - Jul 2	138	0									
Jul 3 - 9	607	23	35	0	0%	9%	86%	5%	0%	0%	0%
Jul 10 -16	1,448	272	26	18	0%	20%	67%	11%	1%	0%	0%
Jul 17 - 23	690	140	33	13	1%	30%	65%	2%	0%	1%	1%
Jul 24 - 29	147	130	34	4	0%	14%	56%	29%	0%	1%	0%
Total	3,030	565		35							

Table 3. Length at age of Chinook salmon sampled at the Gisasa River weir, Alaska, 2006.

	Female					Male				
		Mid-eye to fork length (mm)					Mid-eye to fork length (mm)			
Age	N	Mean	SE	Median	Range	N	Mean	SE	Median	Range
1.1	1	390				0				
1.2	24	527.5	12.1	530	435-690	79	559.9	7.1	545	440-755
1.3	58	735.5	11.0	750	530-900	271	693.2	3.5	690	500-850
1.4	70	837.3	6.6	827.5	720-980	21	799.8	12.5	790	665-900
1.5	1	840				1	560			
2.3	1	820				2	680	50	680	630-730
2.4	1	790				0				
Total	156					374				

Table 4. Age and sex ratio estimates of chum salmon sampled at the Gisasa River weir, Alaska, 2006.

					Brood year and age		
					2003	2002	2001
Strata	Run size (N)	Sample size (n)	Sex ratio % female	Number fish of unknown age	0.2	0.3	0.4
Jun 28 - Jul 2	34,923	0		0			
Jul 3 - 9	126,546	40	43	1	0%	15%	86%
Jul 10 -16	65,284	191	54	16	0%	7%	93%
Jul 17 - 23	27,331	144	59	9	1%	16%	83%
Jul 24 - 29	7,222	167	63	20	1%	24%	76%
Total	261,305	542		46			

Table 5. Length at age of chum salmon sampled at the Gisasa River weir, Alaska, 2006.

	Female					Male				
		Mid-eye to fork length (mm)					Mid-eye to fork length (mm)			
Age	N	Mean	SE	Median	Range	N	Mean	SE	Median	Range
0.2	1	460				1	500			
0.3	46	526.4	4.0	520	480-580	30	561.5	7.1	560	500-640
0.4	235	536.7	1.8	540	470-620	183	570.8	2.3	570	500-660
Total	282					214				

Appendix. Historical Chinook and chum salmon escapement in the Gisasa River, 1960 2006 (source Barton 1984, Melegari and Wiswar 1995; Melegari 1996, 1997; Wiswar 1998, 1999, 2000, 2001; Van Hatten 2002, 2003, 2004, 2005; O'brian and Berkbigler 2005; O'Brian 2006; Alaska Department of Fish and Game unpublished data). * = indicates partial weir count for 1994.

	Aerial index estimates			Weir estimates	
Year	Chinook salmon	Chum salmon	Rating	Chinook salmon	Chum salmon
1960	300	400	Good		
1961	266	0	Good		
1974	161	22,022	Good		
1975	385	56,904	Good		
1976	332	21,342	Good		
1977	255	2,204	Good		
1978	45	9,280	Good		
1979	484	10,962	Good		
1980	951	10,388	Good		
1982	421	334	Good		
1983	572	2,356	Good		
1985	735	13,232	Good		
1986	1,346	12,114	Good		
1987	731	2,123	Good		
1988	797	9,284	Good		
1990	884	450	Good		
1991	1,690	7,003	Good		
1992	910	9,300	Good		
1993	1,573	1,581	Good		
1994	2,775	6,827	Good	2,888*	51,116*
1995	410	6,458	Good	4,023	136,886
1996				1,991	158,752
1997	144	686	Good	3,764	31,800
1998	889		Poor	2,414	21,142
1999				2,644	10,155
2000				2,089	11,410
2001				3,052	17,946
2002				2,025	33,481
2003				1,901	25,999
2004				1,774	37,851
2005				3,111	172,259
2006				3,030	261,305